

## THE NEW COSMOGONY.

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The results established in the writer's "Researches on the Evolution of the Stellar Systems," Vol. II., 1910, have given a new basis to our conceptions of the cosmogony. Instead of the traditional doctrine of throwing off, we now have that of capture, which means essentially that the nuclei originated in the distance and have since grown by accretion as they approached the centers about which they now revolve in greatly reduced orbits of small eccentricity. Not only have we witnessed a radical change in the point of view, but also in the method of research employed. And along with these changes has come the introduction of rigorous mathematical and dynamical criteria by which the mechanical principles involved may be extended over an almost unlimited period of time.

Not the least important of the improvements recently introduced is that resulting from a careful examination of the premises underlying our reasoning. Nothing is adopted from tradition, nor taken for granted, nor from any authority however high; but every question is examined on its merits and from the very ground up. As the subject is new it naturally follows that much still remains to be done; yet the general trend of nature's laws seems to be well established, and cosmogony begins to assume the form of a true science. Accordingly it may not be without interest to the general reader to summarize in one connected view the leading principles of the new science of cosmogony, with brief analysis of the criteria by which they are confirmed.

1. Babinet's criterion based on the mechanical principle of the conservation of areas, by which we are enabled to calculate the times of rotation of the sun and planets when expanded to fill the orbits of their attendant bodies, as imagined by Laplace. This enables us to say at once that the attendant bodies could never have

been detached by acceleration of rotation, as handed down by tradition from Laplace's original nebular hypothesis of 1796.

2. As the planets and satellites could not have been thrown off, they must have been captured and added on from without, or else have been formed from the agglomeration of fine dust right where they now revolve. This latter alternative, however, is easily shown to be impossible, owing to the feeble mutual gravitational attraction of small masses of matter under the stronger tendencies to dispersion by tidal action, which always exist near large centres of attraction. There remains therefore no possible mode of origin for the planets and satellites save that of capture, or addition to the system from without.

3. When first captured the satellites must therefore have been already of such considerable size that they were able to gather in, and consolidate with their globes, numerous smaller masses revolving in the vortices about the planets. The collisions arising in this process of the gathering in of smaller bodies by larger ones are strikingly illustrated by the craters noticed in the face of the Moon, which were formed by impact, the embedded satellites being in some cases at least twenty miles in diameter.

4. Thus while the satellites were all captured,<sup>1</sup> and were originally further from their planets than they are at present, they have grown larger in the course of ages as they revolved in the resisting medium about the planets, just as the earth and primary planets are still growing larger by the impact of meteorites against their surfaces, as they slowly approach the sun. The earth sweeps up daily 1,200,000,000 meteors, and the amount of this dust is calculated to form a layer a millimeter thick in a century.

5. We know the satellites must have grown in mass since they were captured, because they have been drawn nearer and nearer their several planets, by increase of the central attraction, as in the celebrated problem of Gylden.<sup>1a</sup> But if the mass of the sun has increased, by the downfall of cosmical dust, so also must the mass

<sup>1</sup> Since this was written the capture of Satellites has been independently confirmed by Professor E. W. Brown, in an important paper in the *Monthly Notices of the Royal Astronomical Society* for March, 1911, p. 453.

<sup>1a</sup> *A. N.*, 2593.

of the planet or satellite have been correspondingly augmented by the same cause.

6. For whilst the decrease of the major axis of the orbit of a satellite might result wholly from the growth of the mass of the planet and satellite, yet the decrease of the eccentricity of a satellite orbit can be explained only by collisions in the nebular resisting medium. This cause and no other whatsoever will explain the roundness of the orbits so characteristic of the solar system.

7. Accordingly as most of the satellites suffered collisions sufficient to reduce and well nigh destroy the eccentricities of their orbits,<sup>2</sup> it necessarily follows that all these bodies should have their surfaces indented by impacts with smaller masses, just as is shown by the craters on the moon.

8. For whilst Oppolzer, Gylden and others have proved that the growth of the masses by the downfall of cosmical dust would increase the central attraction and bring the bodies close together, it is proved by the mathematical researches of Airy, Herschel, Lehmann-Filhés, and Strömgren, which I have carefully verified, that this decrease in the major axis does not decrease the eccentricity. Hence the decrease of the eccentricity is traceable to no cause whatsoever but the action of a nebular resisting medium, as held in my "Researches," Vol. II., p. 146.

9. The craters on the moon can therefore be due to no cause whatsoever other than the collisions which our satellite has suffered from other small bodies in space, and all divisions of opinion on the subject are henceforth swept away forever. For as the other satellites have had their orbits rounded up in nearing their several planets, it is necessary to suppose the same cause to have acted also on our moon, even if the eccentricity of the orbit in this case has not been rendered excessively small.

10. This solution of the problem of the roundness of the orbits—the leading problem in the cosmogony of our solar system—is what mathematicians call a *unique solution*. It reveals not only a *possible*, but also the *only possible cause of the extremely circular move-*

<sup>2</sup> In section 548 of his "General Astronomy," edition of 1904, the late Professor C. A. Young remarks that the "almost perfect circularity of the satellite orbits is not yet explained."

*ment characteristic of the planets and satellites.* The solution thus possesses all the rigor of a theorem in geometry, and meets the requirements of the most rigorous of the mathematical sciences.

11. The existence of planets beyond Neptune is indicated by the extreme roundness of Neptune's orbit; for this shows that the nebulosity was much too dense at that point for the system to terminate at the present known boundary. Moreover, as I have shown that the planets were originally connected with the comets, and the comets recede to their home in a spherical shell thousands of times the earth's distance from the sun, it necessarily follows that our planetary system extends on almost indefinitely. Several planets of considerable size must be assumed to revolve beyond Neptune, and they may yet be discovered by observation or photography, though at that great distance the practical difficulties will increase, owing to the feebleness of the sun's light and the slow orbital motion, which will require exposures of the photographic plate extending over many hours, and perhaps on successive days.

12. The planets have been built up out of cosmical dust, comets and satellites; so that all the matter now in the planets come originally from the heavenly spaces. This follows from the fact that the nebular development is from the outside toward the center, the formation always beginning in the distance and proceeding by accretion as the bodies gravitate towards the sun, and revolve in ever smaller and rounder orbits. This order of development is directly verified by the phenomena of the spiral and ring nebulae; for here the movement is proved to be towards the center, where the sun develops for the domination of the system.

13. And just as our planets have been added onto the sun from without, not thrown off, as was erroneously taught for more than a century by Laplace and his successors, so also will similar planets have been formed by the same process about the other fixed stars. Thus there are undoubtedly systems of planets about the fixed stars, and they are habitable and inhabited like those revolving about the sun. Moreover, the other suns have their systems of comets, and their planets have captured systems of satellites as in our planetary system. This grand conclusion rests on an incontestable basis and is of transcendent philosophic interest.

14. The causes which have operated in the development of our solar system are thus general throughout the sidereal universe. Everywhere repulsive forces are dispersing fine dust from the stars to form the nebulae, and the nebulae in turn are settling down and whirling around to form stars with planetary systems about them.

15. Professor Barnard's magnificent photographs of the Milky Way show that cosmical dust everywhere pervades the heavenly spaces. And it is proved that variable stars are due chiefly to attendant bodies revolving in resisting media. When considerable bodies come into collision, as a large planet with a sun, the result is a temporary star or Nova.

16. The new cosmogony thus embraces within its scope the chief problems of the universe, and the dynamical causes assigned are deduced from simple phenomena operating according to known laws which are actually verified in the solar system. The arrangement of the nebulae on either side of the Milky Way is the natural outcome of the operation of repulsive forces, the canopy of nebulae congregating as far from the stratum of stars as possible. This assigns a known cause for the great order of nature first brought to light by the telescopic explorations of the elder Herschel in 1785.

Like astronomy itself it is obvious that cosmogony is at once the oldest and newest of the physical sciences. Having renewed its youth by the introduction of definite principles and exact methods, it has recently taken on such vigor that it promises to become the most majestic of the sciences. Nothing is more worthy of the attention of philosophers than the study of the great laws of the physical universe, and the marvelous processes of development by which the beauty and order of the cosmos came about. This was the great problem which gave rise to the development of the physical sciences among the Greeks, and it will always occupy a position of transcendent importance in the domain of natural philosophy.

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